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BIOFUEL ETHANOL TRANSPORT RISK

This Fact Sheet raises awareness of potential safety issues and risks with the transport of biofuel ethanol, and provides information to help address these issues. In the United States, production significantly increased within the last decade (Figure 1). Production is concentrated in the Upper Midwest and transport occurs to all other regions via rail tank cars, tanker trucks, and barges. Traffic at each production facility exceeded 100 deliveries per day in 1999 (Wooley et al., 1999) and will continue to increase rapidly (Kocoloski, et al. 2010). The United States has a goal of tripling production from current levels (http://www.epa.gov/otaq/fuels/renewablefuels/index.htm).

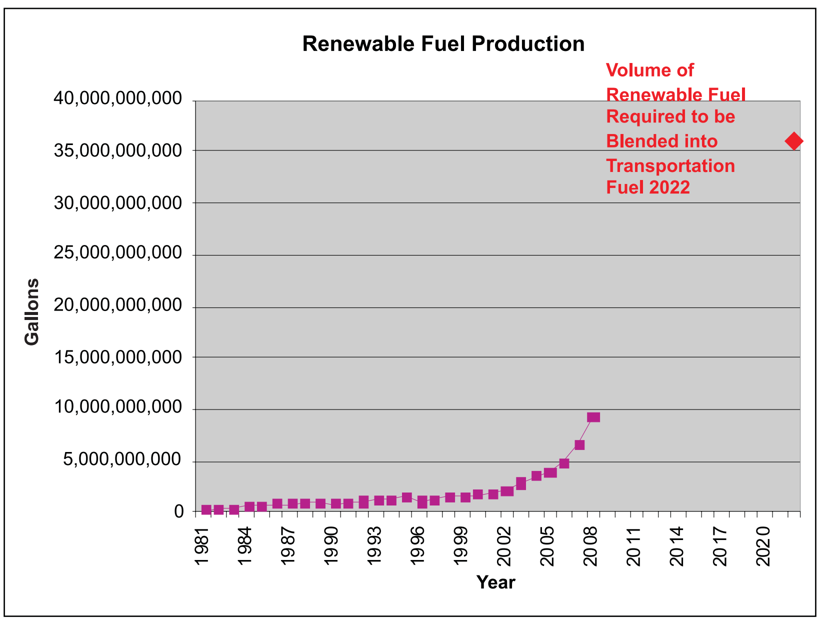

Figure 1. Fuel Ethanol Production 1981-2008; EIA Data (http://www.eia.doe.gov/aer/txt/ptb1003.html).

Many communities lack awareness of the increased and growing extent of biofuel transportation through their jurisdictions. These communities and their emergency responders may not have the information and resources to address spills, explosions, and fires should a biofuel transportation accident occur (www.youtube.com/atch?v=XxI3d1iofts).

Biofuel Ethanol Properties. At various stages in the supply chain, biofuel ethanol may be 100% ethanol or may be mixed with gasoline in varying proportions. All transported fuel is denatured. At refineries or distribution terminals it is mixed with gasoline to produce E10 (10% ethanol/90% gasoline, a common retail blend) and E85 (85% ethanol/15% gasoline). The occurrence of these varying formulations increases the uncertainty when addressing transportation accidents and fires.

Biofuel ethanol has unique properties that affect its transport and safe use. Ethanol may degrade and erode conventional seals, it is hygroscopic (attracts water from the atmosphere), when mixed with gasoline it increases the mobility of spilled mixtures in soil and water, and fuel mixtures with high ethanol percentages can burn with a nearly invisible flame. Ethanol and gasoline have very different properties (Table 1) and mixtures exhibit properties intermediate between the pure components.

Table 1. Fuel Chemical and Physical Properties (adapted from U.S. NRT, 2010, NRT Quick Reference Guide)

	Ethanol	Gasoline
Vapor pressure (at 68 °F)	42 to 44 mm Hg	300 to 500 mm Hg
Vapor density (air = 1)	1.59	3 to 4
Boiling point	173.1 °F	140 to 390 °F
Flashpoint	55.4 °F	-36 °F
Specific gravity (at 68 °F)	0.79 g/mL	0.73 g/mL
Solubility in water	Fully soluble	Poorly soluble
Vapor LEL	3.3%	1.4%
Vapor UEL	19.0%	7.4%
Electrical conductivity	Good conductor	Poor conductor

Biofuel Ethanol Production History and Transportation. Ethanol production increased rapidly after 2000 (Figure 1) from under 2 billion gallons per year in 2000 to over 9 billion gallons per year in 2008. Production is expected to triple by 2022 (http://www.epa.gov/otaq/fuels/renewablefuels/index.htm).

Ethanol is largely produced within the comparatively lightly populated, rural corn-growing regions of the Upper Midwest (Westcott, 2007; Murphy et al., 2011). However, it is transported and used throughout the country, particularly as motor fuel in heavily-populated coastal regions that are far removed from the production centers. Due to the properties of ethanol, it is not transported in existing pipelines but is transported by rail, truck, or barge. Rail shipment is currently the most common choice for transport from production facilities (EERC, 2010), with large volumes carried over long distances (e.g., 80 cars with 2.4 million gallons of capacity per train).

Information and Resources for Communities and Emergency Response. Ethanol/gasoline mixtures require unique precautions and fire-fighting approaches. Fire-fighting foams used for gasoline may be ineffective for fighting biofuel ethanol fires. Training materials for firefighters are available from the Ethanol Emergency Response Coalition (EERC) (http://www.ethanolresponse.com). Railroads and railroad industry groups also provide training for ethanol transportation (e.g., TRANSCAER® (www.transcaer.com/events.aspx).

Fire/explosion risk is the greatest immediate concern at biofuel ethanol accident sites and ethanol fires require the use of alcohol-resistent foam (AR-AFFF). Ethanol alone is considered to not pose long-term environmental problems. However, formulations of ethanol mixed with gasoline can raise additional concerns (e.g., Adair and Wilson, 2010) including methane production (Spalding et al., 2010) and fishkills in surface water. Ethanol spills act differently than pure gasoline. For instance, ethanol/gasoline blends tend to separate when introduced to water bodies, ethanol may promote greater dissolution and mixing of gasoline components in the water column (U.S. NRT, 2010). The need for remediation has to be evaluated on a case-by-case basis.

Risk Reduction. Farm fuel use peaked in 1979 (Cleveland, 1995) and farm energy use is projected to continue a steady decline (Miranowski, 2005). Strategies for minimizing or reducing transportation risk in the future will include increasing use of biofuels in areas geographically closest to the farm economy, thereby reducing the need for long-distance transportation because production already occurs primarily in corn growing regions. This is a step toward relocalization (Heinberg and Bomford, 2009) that will promote sustainability. Risk reduction also includes ensuring an adequate and safe transportation infrastructure, aware and informed communities, and trained and properly supplied emergency personnel.

Statistics that track biofuel ethanol accidents and fires are not available. Government agencies collect extensive information and statistics on transportation accidents involving hazardous materials including fuels; however, biofuel-specific accidents are not readily searchable in these databases. As biofuel production and transportation increase, it may be useful to organize biofuel-specific databases and search capabilities in a form that is easily accessible to communities, especially small jurisdictions.

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